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Notes on the Life History of *Zelotes asiaticus* (BÖSENBERG et STRAND) (Araneae: Gnaphosidae)

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加村隆英[1)]: クロチャケムリグモ（クモ目：ワシグモ科）の生活史

Abstract Life history of *Zelotes asiaticus* (BÖSENBERG et STRAND) was estimated by means of laboratory rearing and field investigation. This species is likely to mature after 8 molts during more than a year after emergence from an egg sac. It seems that this species has a two-year life cycle as follows: Eggs are deposited by the overwintered adult females from spring to early summer; spiderlings emerge from the egg sacs in summer and develop to 2nd–5th instar by winter; juveniles which hibernate their first year develop to penultimates in summer and mature in autumn; and adults overwinter. Possibility of copulation between two populations in which the generation cycles differ from each other is discussed.

Spiders of the Gnaphosidae are hunters usually living under stones and in plant litter on the ground. Our knowledge about life cycle of these spiders it very poor. Many gnaphosid species are likely to have a one-year life cycle, but it may be possible that a two-year life cycle also occurs in the region where warm season is relatively short (GRIMM, 1985).

The life history of *Zelotes asiaticus* (BÖSENBERG et STRAND, 1906), a common gnaphosid species in Japan, is not clear. I conducted a laboratory rearing and a field investigation of this species in order to ascertain its life history.

Materials and Methods

Two females of *Zelotes asiaticus* were captured on 24 April and 30 May 1985 in the moor of Midorogaike Pond in Kyoto City. They were reared in plastic vessels (7 cm in diameter, 3 cm in height), in which wet soil and moss were placed on the bottom. These females deposited egg sacs in due time, and 29 spiderlings emerged. Of these spiderlings, 2 individuals were preserved in alcohol, and 27 ones were reared individually in plastic vessels (4 cm in diameter, 2 cm in height), in which wet cotton was placed. These vessels were kept under laboratory conditions in room temperature. The foods provided were the midges (Chironomidae) and planthoppers (Delphacidae) collected in the field and the fruit flies, *Drosophila melanogaster*, reared in the laboratory, and were renewed every 2 or 3 days. During winter (from mid November to February) spiders were kept in the dark and cool

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place, and only water was provided. Dates of molts of each individual were recorded. Carapace length of exuviae and dead spiders was measured to the nearest 1/40 mm with an ocular micrometer.

Seasonal fluctuations of number of spiders were investigated in the moor of Midorogaike Pond, 21 March–8 November 1982, 11 February–26 December 1984 and 12 March–11 November 1985. Spiders were collected with pitfall traps. The trap was a plastic square case (14×14×6 cm), and 50% ethylene glycol was poured into the case up to the depth of 1 cm in order to prevent the samples from decay. Ten traps were placed at intervals of 5–20 m. The traps were set throughout the study period, and samples were collected every 5–24 days. The collected specimens were divided into 11 categories: the 1st–7th instar juveniles, penultimate males and females, and adult males and females. (In this study, the 1st instar is defined as the stage of an individual just emerged from an egg sac.) Instar of juveniles was estimated by their carapace length based on a measured value of the individuals reared. Specimens whose epigynum was partly formed and palp was swollen were assigned to the penultimate females and males, respectively.

Results

In the laboratory, one female deposited 3 egg sacs from 7 May to 11 June and died on 5 July and the other one deposited 7 egg sacs from 19 July to 25 August and died on 25 August. From 4 egg sacs which were deposited on 7 May, 11 June, 19 July and 12 August, spiderlings emerged on 3 June, 5 July, 5 August and 30 August, and numbers of spiderlings emerged were 13, 7, 6 and 3, respectively.

Of 27 juveniles reared, 15 individuals died by November 1985. Developmental processes of the other 12 individuals which survived later were shown in Fig. 1. Although 11 individuals developed to 4th–7th instar before winter, they died during the winter or by April 1986. One individual which overwintered at 6th instar developed to 7th instar on 9 June and to 8th instar on 28 July 1986. This individual (♀) grew up to the final molt on 19 January 1987, but failed to molt and died before adult.

Carapace length of exuviae and dead individuals obtained from the laboratory

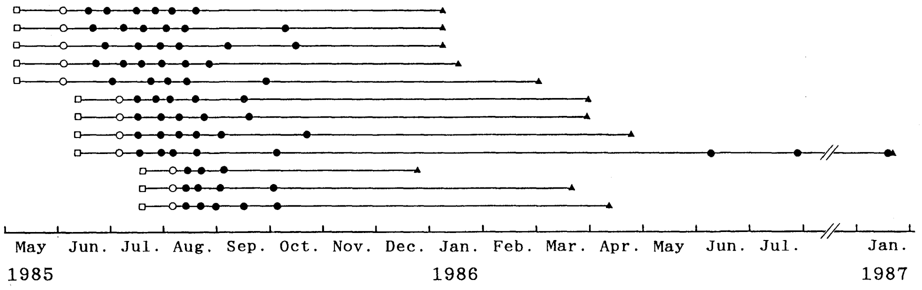

Fig. 1. Developmental processes of individuals reared under laboratory condition. Squares, open circles, solid circles and triangles indicate the oviposition, emergence from egg sac, molt and death, respectively.

Table 1. Carapace length of each instar juvenile in *Zelotes asiaticus*.

Instar	n	Range (mm)	Mean±S.D. (mm)
1st	23	0.65–0.78	0.72±0.03
2nd	21	0.80–0.90	0.86±0.03
3rd	23	0.93–1.10	1.02±0.04
4th	19	1.13–1.30	1.20±0.05
5th	18	1.25–1.53	1.39±0.07
6th	13	1.48–1.83	1.64±1.10
7th	6	1.73–1.88	1.84±0.06

rearing is shown in Table 1. In the 4th and later instars ranges of carapace length were partly overlapped between successive instars. To determine the instar of specimens collected in the field, the range of carapace length in each instar was provisionally defined as follows: 1st, ≦0.78 mm; 2nd, 0.80–0.90 mm; 3rd, 0.93–1.10 mm; 4th, 1.13–1.28 mm; 5th, 1.30–1.50 mm; 6th, 1.53–1.78 mm; 7th, ≧1.80 mm.

Figure 2 shows the seasonal fluctuations of number of spiders collected in the field. First and 2nd instar juveniles appeared from July, 3rd–5th instars from March to November, 6th and 7th instars from May to September, penultimate males and females from July to September. Adults appeared from March to June, and also from September.

Discussion

One female of *Zelotes asiaticus* matured under laboratory condition after 8 molts during about one and a half years after emergence from egg sac. The seasonal fluctuations in number of spiders suggest that this species has a two-year life cycle in this area as follows: Eggs are deposited by the overwintered adult females from spring to early summer; spiderlings emerge from egg sacs in summer and develop to 2nd–5th instar by winter; juveniles which overwinter their first year develop to penultimates in the following summer and mature in autumn; and adults overwinter.

Almost all individuals seem to mature in their second autumn. However, one penultimate female was found in the end of April 1985. This fact suggests that some individuals pass their second winter at penultimate stage and mature in the next spring. This presumption may be supported by the fact that the only individual which could develop to the final molt in rearing did not mature in the second autumn, although the occurrence of the final molt in winter seems to be unusual.

In the laboratory, some juveniles developed to as far as 7th instar by the first winter. On the other hand, in the field, they seem to develop to at most 5th instar by the first winter. Growth rate of spiders is influenced by feeding conditions (Miyashita, 1991). Therefore, the faster development in the present rearing may be caused by full feeding in the laboratory. Moreover, if the reared individuals supplied with much food were larger in body size than the field ones, the number of instar of the field individuals may be underestimated in this study.

Since this species has a two-year life cycle, there are, in principle, two popula-

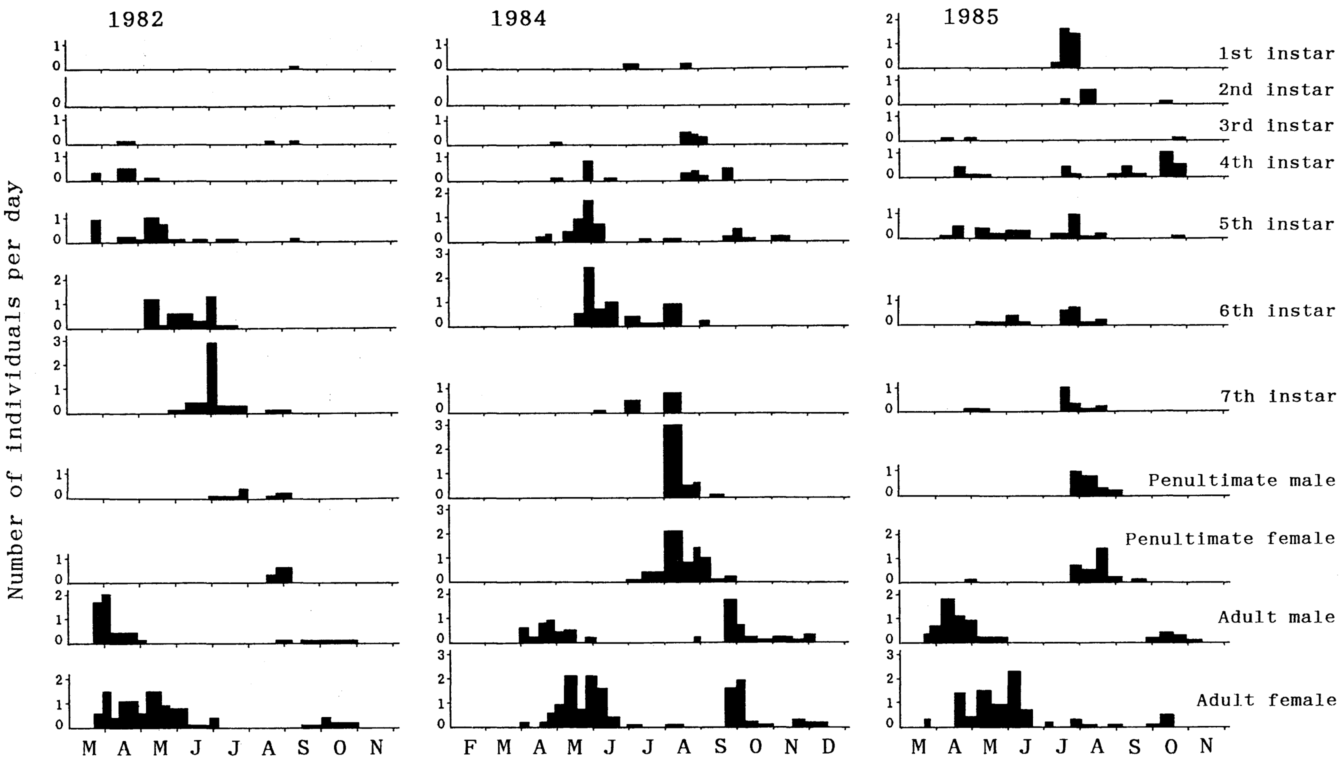

Fig. 2. Seasonal fluctuations of spiders, 1st instar juveniles to adults, collected by pitfall traps, in 1982 and 1984–85, Kyoto, Japan.

tions which are reproductively isolated. Gene flow between the two populations may occur at least partly. COYLE (1985) suggested that in the population of *Hypochilus* sp., with a two-year life cycle, some individuals rarely live more than two years and reproduce for more than one breeding season. In *Sitticus fasciger* (SIMON), which has also a two-year life cycle, it seems that some males which matured in the previous year survive until the following autumn and copulate with just matured females (MATSUMOTO and CHIKUNI, 1987). Besides, KAIHOTSU (1988) confirmed that *Shinobius orientalis* (YAGINUMA) has a two- or three-year life cycle and in this species some adult females overwinter after the first oviposition and reproduce again in the next year. The life cycle pattern of *Zelotes asiaticus* is similar to that of *Sitticus fasciger*, but there is little possibility that males survive until autumn in the former species because the field investigation indicates that the males entirely disappeared by June. However, in *Z. asiaticus* females may survive until autumn and copulate with the newly emerged males. Granting that this is true, it is uncertain whether the females oviposit in the autumn or they overwinter and oviposit in the next spring as *Shinobius orientalis*.

On the other hand, in *Neriene radiata* (WALCKENAER) some individuals which hatch from eggs laid in spring mature and reproduce in summer, while the others grow more slowly and mature in the next spring (WISE, 1976). Such a variability of growth rate may exist in *Z. asiaticus*. If some individuals which emerged from egg sacs in summer grow rapidly and mature in the next spring, they may be able to copulate with individuals one year older than themselves.

Although it is possible that the phenomena stated above occur in *Z. asiaticus*, the mechanism of copulation between two populations is not clear at present.

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摘要

クロチャケムリグモ *Zelotes asiaticus* (BÖSENBERG et STRAND) の生活史を知るために，室内飼育と野外調査を行った．本種は出嚢後，1年以上をかけて成熟し，その間に8回の脱皮を経ることが示唆された．生活史は以下のように推定された．産卵は春から初夏にかけてなされ，夏に子グモが孵化し，冬までに2～5齢幼体にまで成長する．越冬した幼体は夏に亜成体となり，秋に成熟し，成体はさらに越冬する．つまり，2年で1化を経過する．また，発育段階が1年ずれたふたつの集団間における生殖的交流の可能性について考察した．

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